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FLOOD AS ECOLOGICAL PERTURBATION OF EPIGEIC ANIMAL COMMUNITIES II. THE EFFECT OF FLOOD ON GROUND BEETLE ASSEMBLAGES (COLEOPTERA: CARABIDAE)

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Abstract

Author reports on the processing of the material collected by means of Barber soil-traps at four different habitats at the flood-plain of the Maros (I. dam-side, II. poplar-forest, III. willow-forest, IV. littoral scrub-willow plantation), following the flood of 1982 inundating the whole flood-plain. In the course of the studies 53 species of 18 genera belonging to the Carabidae family were collected. Using diversity and similarity studies, an analysis is given of the dynamism of the Carabidae populations, their recolonization after the flood, as well as of the reorganization of the Carabidae communities.

Introduction

One of the basic problems of ecology of our days is related to the degree to which the living being communities can be burdned, is in connection with the stability of these communities, as well as with their return to the original state following perturbation. This issue is given particular significance by the fact that these may provide direction and solution for the protection of our natural environment nowadays falling into decay more and more faster and to a significant degree as the consequence of the anthropogenic effects, as perturbating factors, furthermore, for arrangements on professional ground in respect to environmental protection and nature conservance. Due to the frequent floods, as natural perturbating effects, the biocenoses at the flood-plain of the Tisza and Maros are particularly suitable for such studies. The relevant earlier investigations were of faunistic character (VÁNKY and VELLAY 1894), BICZÓK 1936). A few authors have made mention of the effect of floods on the coleoptera communities (STILLER 1932), and of their fauna-spreading role, resp. (ERDŐS 1935). The problems of recolonization following floods and of the reorganization of the flood-plain communities have been studied by BODROGKÖZY and HORVÁTH (1979) as well as partly theoretically by GALLÉ, GYŐRFFY and HORNUNG (1982), based on the data of TANÁCS (1979).

The ground beetles are explicitly of epigeic activity, thus mainly their larvae react rather sensitively to inundation. Several authors have studied the effects of the factors which may play role in the recolonization of the ground beetles following flood as well as in the reorganization of their communities. Many studies have been carried out regarding the effect of light, temperature, soil- and air-humidity in single or in their connections (THIELE 1967, 1968, 1977, PAARMANN 1966). Based on the obtained results it could be determined that the soil- and air-humidity are decisive environmental factors in respect to the linkage of the ground beetles to habitat. Some authors have studied the possibilities of survival after floods. Certain species are capable of enduring a short period of submersion in a particular stage of ontogenesis (PALMÉN 1945, TAMM 1984), while others attempt to avoid the effect of floods by means of over-wintering (KREHAN 1970, PALMÉN 1948, TISCHLER 1965). Vagility has great significance in settlement following flood. KÜHNELT (1965) studied the activity of a few Bembidion species bound to the direct water border and found that they are even capable of flying to considerable (several km) distances. Great significance is attributed by THIELE (1977) to interspecific competition, too, in settlement and linkage to living-space.

Materials and Methods

The studies were performed over a period of three years (between 1982—1985) at the flood-plain of the Maros, about 5 km above the mouth. Following the flood of 1982 inundating the whole flood-plain 5 ethylene-glycol soil-traps from plastic cups 6 cm in diameter were placed at four different habitats well distinguishable on the basis of their plant communities. The traps were emptied at intervals of 14—28 days. Since the relief-height of the sampling sites is an essential factor from the viewpoint of inundation, this was given in proportion to the 0 point of the Szeged water standard falling the closest (Fig. 1).

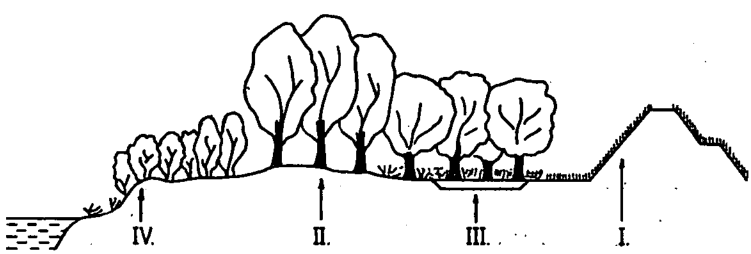

Fig. 1. Cross-section of the flood-plain with the sampling sites (I) Inner dam-side *(Agrostio-Alopecuretum ass.)*; (II) Poplar-willow plantation *(Salicetum a. f. populetosum ass.)*; (III) Mulberry-willow plantation *(Salicetum a. f. rubetosum ass.)*; (IV) Littoral scrub-willow plantation *(Salicetum triandrae ass.)*

The comparative processing of the data of occurrence per sample was accomplished on the basis of diversity and similarity indices according to SOUTHWOOD (1984).
Diversity:

$$H_{(s)} = - \Sigma\, pi \times \lg pi$$

where pi = relative frequency of the ith species

$$C_{Czekanowski} = \frac{2\, \Sigma \min (X_{ij};\ X_{hj})}{\sum_j X_i + \sum_j X_h}$$

where X_i and X_h = relative frequency of the i and h species.
For the cluster-analysis of the similarity indices a TI 99/4A personal computer was used.

Results and Discussion

In the course of the studies a total of 4138 individuals were collected, — 53 species of 18 genera belonging to the Carabidae family. The data of occurrence of the 25 most frequent species were also analysed separately (Table 1).

To study the effect of the floods on syndynamic processes, it is necessary to review when floods inundated the flood-plain, to what degree and for how long at the studied period and directly prior to that (Fig. 2). In 1982 at the period prior to

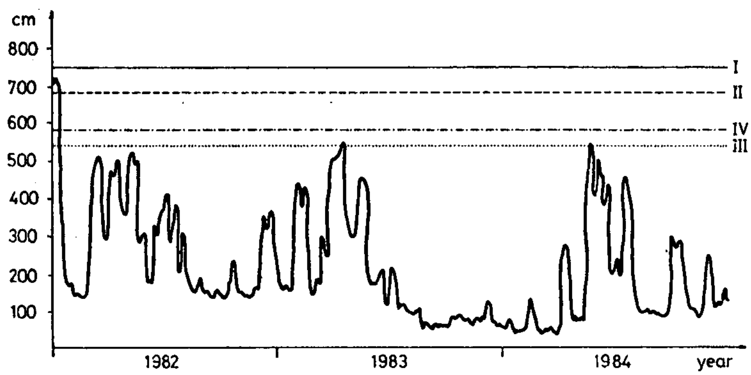

Fig. 2. Development of the floods at the studied period and directly before. I. II. III. and IV: relief-height of sampling sites

the first collection, there was a flood lasting about twenty days which was of such degree (717 cm on 11th January, 1982) that it inundated areas II., III. and IV. Later on there were only floods of 450—550 cm, only disturbing the communities of sampling sites III. and IV.

It follows from the character of the soil-trap — as relative trap-method — that far-reaching consequences cannot be drawn from the obtained data in respect to the composition of the flood-plain zoocenoses. Nevertheless, it could be determined that at sampling sites II., III. and IV. which are covered by forests, the ground beetles are the dominant elements of the epigeic carnivorous communities (Table 2).

After the flood inundating the whole flood-plain the changes in diversity differed at the different sampling sites (Table 3). Year by year there was a decrease in the diversity at the dam-side (I.) serving as a place for temporary shelter. At the areas (II., III. and IV.) where the communities were greatly disturbed before the studies by the flood of almost 720 cm, an increase was experienced in the species diversity of the ground beetles. This could be explained by the fact that at the time of the greater flood the ground beetles fleeing to the dam-side gradually resettled at the flood-plain and their occurrence at the dam-side became more and more incidental.

The Czekanowski indices calculated for comparing the species composition of the four different habitats (Table 4), and the dendograms constructed on the basis of these (Fig. 3) are supportive of the fact that the ground beetle community caught at the dam-side differs from the rest. In the years following the flood a process of differentiation commenced at the II., III. and IV. habitats, in the course of which the composition of the ground beetle communities of the IV. waterside began to differ from that of the II. and III. forest communities.

Table 1. *List, individual number of collected species and code-number used in the cluster-analysis regarding the 25 more frequent species*

Species	Code number	Number of Collected individuals		
		in 1982	in 1983	in 1984
Carabus cancellatus	(1)	12	8	14
C. granulatus	(2)	169	123	51
Leistus rufescens		—	—	3
Elaphrus riparius	(3)	46	34	17
Clivina fossor	(4)	31	4	4
Dyschirius globosus	(5)	39	52	33
D. rufipes		—	2	—
Asaphidion flavipes	(6)	6	15	99
Bembidion foraminosum	(7)	6	1	—
B. laticolle		1	2	2
B. ustulatum	(8)	3	8	16
B. biguttatum		—	2	1
B. dentellum	(9)	13	3	—
B. varium	(10)	7	11	2
Patrobus atrorufus	(11)	—	10	5
Amara ovata		1		—
A. eurynota		3	1	—
A. similata		—	4	—
A. familiaris		—		2
Pterostichus cupreus	(12)	31	10	3
P. vernalis	(13)	11		3
P. lepidus		—	3	—
P. niger	(14)	241	56	81
P. nigrita		—	3	1
P. anthracinus	(15)	—	30	40
P. melanarius	(16)	232	139	336
Agonum ruficorne	(17)	11	5	3
A. nigrum		—	3	3
A. obscurum	(18)	33	39	70
A. livens		—	2	7
A. versutum		—	—	1
A. assimile	(19)	863	430	273
A. thoreyi	(21)	1	—	29
Platynus (Agonum) dorsalis	(20)	7	3	4
Stomis pumicatus	(22)	3	16	27
Badister bipustulatus		3	3	1
B. peltatus		18	11	—
Chlaenius nitidulus		—	1	—
Ch. nigricornis		—	1	—
Ch. festivus	(23)	6	—	—
Anisodactylus signatus		—	2	1
binotatus		1	1	1
Harpalus affinis		2	1	—
H. rufipes	(24)	37	30	78
H. latus		—	—	2
H. griseus		—	—	1
Acupalpus meridianus		—	1	—
A. discophorus		—	3	1
A. teutonus		—	1	—
Brachinus plagiatus		—	1	2
B. crepitans	(25)	—	—	9

Table 2. *Ratio of Carabidae among the epigeic carnivores*

Predator group	Sampling sites							
	I		II		III		IV	
	X*	D%	X	D%	X	D%	X	D%
Chilopoda	38	1,60	147	2,97	361	7,47	47	3,10
Carabidae	119	5,00	2025	40,93	1216	25,16	778	52,71
Formicoidea	927	38,92	169	3,42	150	3,10	14	0,95
Arachnoidea	1298	54,49	2607	52,69	3105	64,26	637	43,16
Total:	2382		4948		4832		1476	

* X: individual number; D%: dominance

Table 3. *Changes in diversity in the studied years*

Year	Sampling sites			
	I	II	III	IV
	Diversity H(S)			
1982	1,57	1,82	1,62	1,64
1983	1,23	1,89	2,28	1,64
1984	1,18	1,96	2,33	2,04

Table 4. *Similarity between sampling sites calculated with the Czekanowski index*

	Sampling sites			
	I.	II.	III.	IV.
I.	—	0,01* 0,04 0,11	0,03 0,05 0,02	0,02 0,02 0,11
II.		—	0,43 0,39 0,60	0,52 0,17 0,22
III.			—	0,49 0,16 0,23

* the upper values are the data of 1982, the median values of 1983, the lower values of 1984.

Based on the data of occurrence of the 25 more frequent species a cluster-analysis was calculated as the result of which different species-groups could be separated, corresponding to the communities of the four habitats (Fig. 4):

I. sampling site: *Carabus cancellatus, Harpalus rufipes,* a few herbivorous species (*Amara* spp.) not found in the figure because of their rarer occurrence.

II. sampling site: *Bembidion dentellum, Pterosticsuh cupreus, Agonum assimile, Asaphidion flavipes, Dyschirius globosus, Pterostichus niger, Brachinus crepitans.*

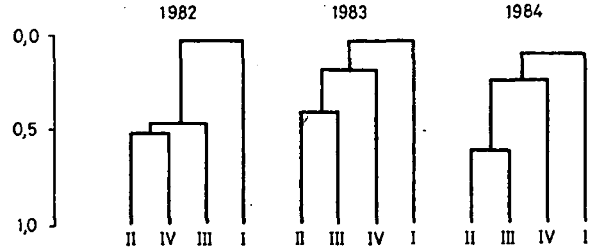

Fig. 3. Dendrograms prepared on the basis of the similarity indices calculated for the Carabidae-communities of the four different habitats. I, II, III. and IV: sampling sites

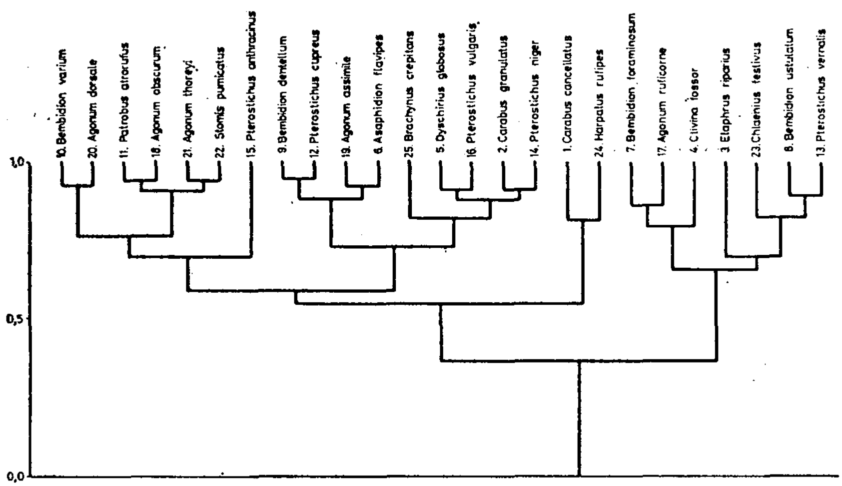

Fig. 4. Dendrogram prepared on the basis of the similarity indices calculated from the data o occurrence of the 25 most frequent species

III. sampling site: *Bembidion varium, Platynus (Agonum) dorsalis, Patrobus atrorufus, Agoum obscurum, Agonum thoreyi, Stomis pumicatus, Pterostichus anthracinus.*
IV. sampling site: *Bembidion foraminosum, Agoum ruficorne, Clivina fossor, Elaphrus riparius, Chlaenius festivus, Bembidion ustulatum, Pterostichus vernalis.*

Upon examining the development of the similarity indices expressing the degree of joint occurrence of the species in the course of the years (Table 5), it can be seen If, for example, we choose the similarity value of 0.6 — indicating a tighter connection — as the limit value for the joint occurrence, species-groups can be differentiated in all three years. It is interesting to study to what extent the composition of the developing species-groups differs and shows similarity, respectively, in the years following the flood (Table 6).

Upon comparing the groups of the previous years with the year of 1984 (which can be characterized by well developed species communities being the farest from the greatest flood, thus presumedly the least influenced), it can be found that in 1982 — directly after the flood — there were only 14, while in 1983 there were 22 connec-

Table 5. *Number of tight joint occurrences and the number of species occurring tightly together in the studied years*

	1982	1983	1984
Values of the Czekanowski index	Number of joint occurrences		
0,9<	6	8	9
0,8<	11	14	15
0,7<	15	14	17
	Number of species occurring together		
0,9<	12 faj	11 faj	14 faj
0,8<	17 faj	18 faj	22 faj
0,7<	19 faj	18 faj	22 faj

that in case of the values above 0.8 and 0.9 there is an increase from year to year in the number of species-pairs repeatedly and tightly occurring jointly. If considering that not only jointly occurring species-pairs, but also species-triads and species-groups, resp., can be segregated, it follows from this that not only the number of joint occurrences increases, but also the number of jointly occurring species (Table 5).

Table 6. *Correspondence of the species-groups of the previous years to the species-groups of the year 1984*

1982		1983		1984
Species—groups				
20—19—24—9—7—17		1—24		6—12—1—25—11—5——19—16—17—20
23—6—13—3—8—4		15—17—7—20—10		2—22—18—21—13——4—14—15
18—5—12—16—21——10—2—14		4—22—18—11—2——16—5—9—14—6—19		7—3—10—8
		12—18		
Correspondence to 1984				
12—5	2—18	6—11	2—22	
12—16	2—21	6—5	2—18	
5—16	2—14	6—19	2—4	
19—17	21—18	6—16	2—14	
19—20	18—14	11—5	18—22	
17—20	21—14	11—19	22—4	
13—4	3—8	11—16	22—14	
		5—19	18—4	
		5—16	18—14	
		19—16	4—14	
		17—20	7—10	

* the species belonging to the code-numbers are found in Table I.

tions corresponding to those of the year 1984; i.e. there were two species in the same linkage-group.

The increase in the number of joint occurrences and jointly occurring species, as well as the yearly increasing conformity of the species-groups refer to the fact that a structural process starts after the flood, and also presumably the regeneration of the co-existence pattern characteristic to the longer flood-free period. The few species *(Carabus granulatus, Pterostichus niger, Agonum obscunum, Agonum assimile, Pterostichus melanarius, Platynus (Agonum) dorsalis, Dyschirius globosus)* which showed relatedness during all three years are presumably capable of tolerating well the identical effect of flood — showing certain resistance — and the cause of their tolerance is with all probability their great vagility, extreme opportunism, or their other r-strategic nature.

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Árvizi perturbáció ökológiai hatása epigeikus állatközösségekre. II. Árvíz hatása futóbogár együttesekre

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Kivonat

A szerző a Maros hullámterén, az egész hullámteret elborító 1982-es árvizet követően négy különböző habitátban (I. gátoldal, II. nyárerdő, III. füzeserdő, IV. partmenti bokorfüzes) Barber féle talajcsapdával gyűjtött anyag feldolgozását közli. A vizsgálatok során a Carabidae család 18 genusának 53 faját sikerült begyűjteni. Diverzitási és szimilaritási vizsgálatokkal elemzi a Carabidae populációk dinamizmusát, az árvíz utáni rekolonizációt, a Carabidae közösségek újraszerveződését.

Poplava, kao ekološka smetnja životinjskim zajednicama iznad zemlje II. Delovanje poplave na zajednice strižibuba (Coleoptera: Carabidae)

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Abstract

Autor pritazuje materijal sakupljen Barber klopkama u plavnom prostoru Maroša-posle 1982. godišnje poplave-iz 4 različitih mesta (I. nasipna strana, II. topolina šuma, III. vrbak, IV. žbunasti vrbak duž obale).

Tokom istraživanja sakupljeno je 53 vrste iz 18 genusa familije Carabidae.

Sa metodom diverziteta i similariteta analizira dinamizam populacija Carabidae, posle-poplavnu rekolonizaciju i ponovno organizovanje zajednice Carabidae.

Тормозящее экологическое воздействие наводнений на надпочвенные сообщества животных II. Влияние наводнений на сообщества дровосеков

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Резюме

Автор сообщает результаты обработки материала, собранного с помощью ловушки типа Барбер, на территории поймы реки Марош после наводнения в 1982 году в четырех различных зонах (I. склоны дамб, II. осиновый лес, III. ивняк, IV. береговые заросли ивового кустаника). В ходе исследований собраны 53 вида 18 родов семейства Carabidae. С помощью дивергенции и исследования симиларитета анализированы динамизм популяций Carabidae, реколонизация после наводнения и восстановление сообщества Carabidae.